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Developing User Sophistication in the Organization: An Empirical Investigation

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Executive Summary
This paper reports on a study to identify and investigate the factors which further worker sophistication in the use of computers. Quantitative data were gathered from 194 computer users and the PLS implementation of structural equation modelling then used to test a conceptual model of user sophistication. The research findings emphasised the importance of computer self-efficacy, on-the-job opportunities to use computers, requisite training, and computer use; all were found to have positive effects on user sophistication. Task uncertainty was shown to negatively impact user sophistication. Contrary to expectation, organisational support had a negative effect on user sophistication. Important corroboratory evidence was also found for the role of computer self-efficacy in explaining IT-related behaviours. Overall, the research findings advance current understanding of how user sophistication is developed in, and influenced by, the working environment. The study concludes with a discussion of the implications for practitioners regarding the assessment and development of computing skills in the workplace.

1. Introduction
One of the most perplexing issues, which has plagued information systems (IS) practitioners and researchers alike, concerns the payoffs from organisational investments in information technology (IT). Recent studies suggests these expected payoffs are to be found, not in positive impacts on business performance, but in higher productivity and significant value created for consumers (Hitt and Brynjolfsson 1994). Yet, some organisations are lacking in necessary IS knowledge and specific computing skills; indeed, some users are satisfied with learning just enough about the technology to assist their every day tasks (Cragg and Zinatelli 1995; Mirani and King 1994). This lack of expertise and motivation towards skills development can have debilitating effects on factors such as productivity improvements and IS growth and sophistication (Cragg and Zinatelli 1995; Mahmood and Mann 1993).

Deriving business gains through IT investment is likely to require, among other factors, sophisticated users - individuals who are able to go beyond basic computing towards using IT for operational and strategic gain. Efforts to enhance IT investment value should therefore include an understanding of the factors that further worker sophistication in using computing technology. Except for a few studies regarding instrument development and some aspects of user ability (Huff et al. 1995; Nelson and Cheney 1987; Rahman and Abdul-Gader 1993), the agenda for user sophistication research has received little attention. In considering the gaps in the literature, there is a need to investigate how and why sophistication is developed. This research therefore seeks to extend current understanding of user sophistication by *investigating the factors which determine the development of user sophistication.*

In their endeavours to study the different user types, some researchers have developed typologies for 'pigeon-holing' individual users and for assessing the varying levels of computing competency exhibited (Rockart and Flannery 1983), while others have used applications development as a benchmark to distinguish the more sophisticated user from the less sophisticated user (Mirani and King 1994). However, users have evolved, over time, into subtle variations of these characterisations and can no longer be neatly slotted into the finite sets of categories developed. Researchers are now examining user ability in terms of knowledge and skills across a number of computing knowledge areas (Nelson and Cheney 1987; Rahman and Abdul-Gader 1993). One such approach, labelled the 'sophistication' view of end-user computing capability, encapsulates the general measures of ability, such as knowledge and understanding of basic computing concepts, and familiarity with specific applications, but goes further by endeavouring to capture more detailed information on different types of abilities (Marcolin et al. 1993).

This view of user sophistication is conceptualised as three independent dimensions of user capability: breadth of capability, depth of capability, and finesse. *Breadth of capability* refers to the extent or variety of different tools, skills, and knowledge that an individual possesses and can apply to his or her job. This assumes at least minimal competence in the relevant computing domains. *Depth of capability* is assessed by the completeness of the user's current knowledge of a particular computing domain. This includes mastery of the features and functions of different types of application systems, practices, and techniques, and the degree to which these tools can be applied through the range of tasks for which they were designed. *Finesse* describes the ability to creatively apply computing technology. Embracing more than a comprehensive grasp of the commands and capabilities of certain application packages and technologies, finesse includes innovativeness and creativity in the practical use of the technology and an ability to find new or unusual ways of effectively using the technology in the organisation. Three areas of computing knowledge (the *major computing domains*) are identified as important to an evaluation of user capabilities. These are: hardware, software, and computing concepts and practices.

The remainder of this paper defines a conceptual model of user sophistication. The research method is then described, the results presented, and the research contributions, limitations, and implications discussed.

2. A Conceptual Model Of User Sophistication

To further user sophistication, it is important that users are able to obtain experiences that push back the boundaries of current computing knowledge and skills. This discussion advances a number of factors as predictors of user sophistication; these are expected to impact user sophistication through the acquisition of requisite experiences for skills development.

Training is identified in the literature as a key factor influencing user ability and the acquisition of computer skills (Compeau and Higgins 1995a; Nelson and Cheney 1987). Education was found to be related to breadth of capability (Huff et al. 1995). Organisational support which addresses user needs and supports users in their use of new software applications can also be expected to augment the development of user sophistication. For example, Mirani and King (1994) found that the support needs of users increased uniformly and fairly steeply along the user sophistication spectrum from non-programming users through to functional support users.

Task uncertainty and computing opportunities are also considered in this study, as important for skills development. For example, Wood (1986) observed that variances in task uncertainty produced changes in the knowledge and skill requirements for successful task performance; hence, task performance was lowered in the presence of high levels of task uncertainty. In this study computing opportunities was conceptualised as opportunities to develop sophistication (i.e., the extent to which users are provided with or actively obtain computer-related experiences that enhance current skills) and task-technology fit. Prior research suggests an association between opportunities to use technology and skill development (Kasper and Cerveny 1985; Rivard and Huff 1985). Task-technology fit also has important implications for user sophistication by providing users with on-the-job opportunities to use acquired computing skills (Schiffman, Meile and Igbaria 1992; Wood and Bandura 1989). Research also shows computer use to be an important consideration for user sophistication (Huff et al. 1995; Nelson and Cheney 1987).

Finally, Bandura's (1977) perspective on self-efficacy has been particularly useful in the study of IT-related behaviours (Compeau and Higgins 1995b; Igbaria and Iivari 1995). Self-efficacy in computing behaviour is defined as *computer self-efficacy*, that is, "a judgement of one's capability to use a computer" (Compeau and Higgins 1995b, p. 192). Computer self-efficacy is concerned, not with past achievements, but with judgements of what can be accomplished in the future; it does not refer to simple component skills (like formatting diskettes), but incorporates judgements of one's ability to apply those skills to broader tasks (e.g., preparing written reports). Given the appropriate skills and adequate incentives, self-efficacy can be expected to influence factors such as choice of activities and environment, effort and perseverance in the face of difficulties, and whether thought patterns are self-hindering or self-aiding (Bandura 1977). Computer self-efficacy has important implications for user sophistication; for example, the role of self-efficacy is well-documented as a key variable in respect of intentions to learn about computers, skill development and higher performance levels, and user sophistication (Compeau and Higgins 1995a; Hill, Smith and Mann 1987; Huff et al. 1995). Consistent with the discussion of the determinants of user sophistication, it is expected that (see Figure 1):

Hypothesis 1a: Training will have a positive effect on user sophistication.
Hypothesis 1b: Education will have a positive effect on user sophistication.
Hypothesis 1c: Organisational support will have a positive effect on user sophistication.
Hypothesis 1d: Task uncertainty will have a negative effect on user sophistication.
Hypothesis 1e: Computing opportunities will have a positive effect on user sophistication.
Hypothesis 1f: Computer use will have a positive effect on user sophistication.
Hypothesis 1g: Computer self-efficacy will have a positive effect on user sophistication.

Judgements of self-efficacy derive from sources such as performance accomplishments, vicarious experiences, and verbal persuasion (Bandura 1986), which may be operationalised in the workplace through factors such as training, education, organisational support, task uncertainty, and computing opportunities. For example, research has shown training to positively impact the formation of computer self-efficacy (Compeau and Higgins 1995a). Education was found to be related to computer anxiety (Igbaria 1993) suggesting that education may boost self-efficacy through its inverse effect on anxieties. Individuals in assessing their ability to perform may rely, in part, on the opinions of others who presumably possess evaluative competence (Bandura 1986); for example, Igbaria and Iivari (1995) found positive associations between self-efficacy and management encouragement and EUC support. Through an assessment of task difficulty, task uncertainty may negatively impact self-efficacy; individuals may infer a high level of efficacy from successes achieved through minimal effort, and a low sense of self-efficacy if they have to work hard, under favourable conditions, to master relatively easy tasks (Bandura 1986). Computing opportunities also have strong implications for self-efficacy; Wood and Bandura, (1989) found that users needed to experience sufficient success when using newly acquired skills in order to develop efficacy. Consistent with this discussion, it is expected that:

Hypothesis 2a: Training will have a positive effect on computer self-efficacy.
Hypothesis 2b: Education will have a positive effect on computer self-efficacy.
Hypothesis 2c: Organisational support will have a positive effect on computer self-efficacy.
Hypothesis 2d: Task uncertainty will have a negative effect on computer self-efficacy.
Hypothesis 2e: Computing opportunities will have a positive effect on computer self-efficacy.

In considering the role of computer use in respect of user sophistication, prior research also suggests direct associations between the antecedents and computer use. For example, both training and education have been positively associated with the use of computers (Igbaria 1993; Igbaria, Guimaraes and Davis 1995; Nelson and Cheney 1987). Organisational support was also shown to impact computer use; for example, Igbaria, Guimaraes and Davis (1995) reported positive associations between support and system usage. Task uncertainty was found to positively influence computer use; Culnan (1983) observed that computer use was greater in the more complex task environment. Computing opportunities has important implications for computer use; for example, job-fit was shown to impact computer use (Thompson, Higgins, and Howell 1991). Finally, strong associations have been suggested between self-efficacy and computer use; individuals with a high sense of computer self-efficacy were found to use computers more (Compeau and Higgins 1995b; Igbaria and Iivari 1995). Hence, it is expected that (see Figure 1):

Hypothesis 3a: Training will have a positive effect on computer use.
Hypothesis 3b: Education will have a positive effect on computer use.
Hypothesis 3c: Organisational support will have a positive effect on computer use.
Hypothesis 3d: Task uncertainty will have a positive effect on computer use.
Hypothesis 3e: Computing opportunities will have a positive effect on computer use.
Hypothesis 3f: Computer self-efficacy will have a positive effect on computer use.

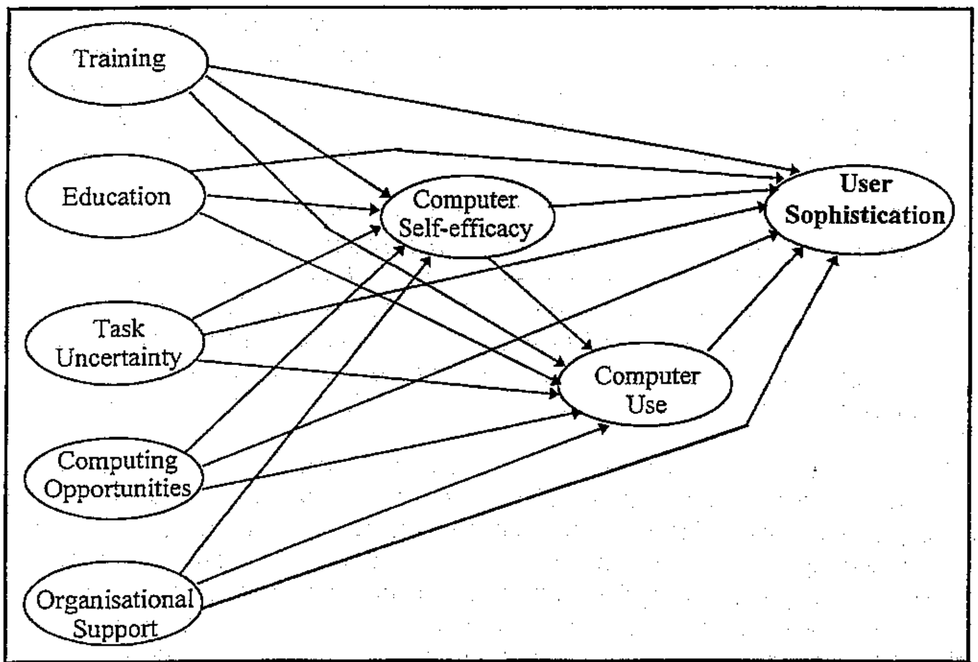

Figure 1: The Research Model

The research model (in Figure 1) implies links between the independent variables and i) user sophistication through computer self-efficacy and computer use, and ii) computer use through computer self-efficacy. These relationships suggest partial mediation to the extent that the intervening variables account for a portion of the effect of the predictors on the dependent variable. The analysis of the structural model is expected to indicate the strength of these paths.

3. Research Methodology

The Sample

The population of research interest consisted of individuals who use computers to perform work-related tasks. *Purposive sampling* based on suitability, population size, and a willingness to participate in the study, was used to select the participating organisation – a health corporation. Following discussions and a pre-test with 25 participants, the study was determined inappropriate for clinical staff whose functions focused on patient-care and whose use of computers consisted of chauffeured access to the organisation's medical information system for performing tasks such as patient admissions and discharges. These employees were excluded from the sampling frame, yielding a population of 604 users. Under advisement, a response rate of 25 percent was estimated; to ensure an adequate sample size, a *census* rather than a sample was taken.

Under the Privacy Act (1993) participant information were unavailable. A 'blind' approach to survey administration was assumed; hence, the correspondence and surveys were prepared by the researcher and their distribution managed by the organisation. Potential participants were notified in writing of the impending survey and its intent, and given the opportunity to decline participation or to request further information. This was followed by survey distribution (including a covering letter, the questionnaire, and a self-addressed return envelope). Since individual non-respondents could not be identified, reminders were sent to all survey recipients following the return date specified. An achievable sample of 537 users (excluding non-contacts and pre-test participants) was determined. Of these, 225 (41.9%) responded and 194 of these surveys were useable. Although the low response suggested *non-response bias*, since non-respondents could not be identified nor were the data required for estimating non-response available, these effects could not be determined. Interpretation of results should therefore consider the likelihood of non-response bias and any implications.

The 194 respondents covered the full range of health and support divisions (79.8%), and administrative services (20.2%). Of these, 23.7 percent were clinical staff including medical and nursing staff (7.7%) and allied health professionals (16%). The non-clinical group (65.5%) included, accounting and finance staff (9.8%), administrators (13.4%), IS staff (9.3%), personnel staff (1.5%), and secretarial and clerical personnel (31.4%). Respondents held positions ranging from managerial and supervisory (30.9%), to professional and technical positions (31%), and secretarial and clerical positions (33%). Ages ranged from 18 to 61, with an average age of 38.8 years (*SD* = 10.6). Of the respondents, 68 percent were female and 31.4 percent were male (1 was unknown). Average organisational tenure was 7.4 years (*SD* = 6.7); for the current job, average tenure was 3.6 years (*SD* = 4.3). Of the respondents, 47.9 percent were college or university graduates, while 30.4 percent had completed some college or university study. The remainder (21.6%) had completed a high school qualification or less.

Operationalising the Study Variables

The following measures correspond to the constructs examined in this research:

User sophistication was assessed as breadth of capability, depth of capability, and finesse (Huff et al. 1995). For breadth of capability and depth of capability, respondents were asked to indicate (for each of 31 items) whether or not they had used, or had any knowledge of the particular item and if so, to rate their current level of knowledge on a 7-point scale ranging from (1) "Very limited knowledge" to (7) "Complete knowledge". An index for breadth of capability was calculated as the number of items which the respondent had used or knew about. The index for depth of capability was assessed as the sum of the scale responses. To assess finesse, the respondents recorded, for each of five items, the response (on a corresponding 7-point scale) which best approximated their ability to creatively use computer tools and technology. The sum of the scale responses was used as an index for finesse.

Computer self-efficacy was measured in terms of efficacy perceptions and performance over a range of conditions of increasing task difficulty (Compeau and Higgins 1995b). The respondents were asked to indicate whether or not they believed they could accomplish a hypothetical task using an unfamiliar software package, under each of ten conditions, and if so, to rate their level of confidence on a 10-point scale ranging from (1) "Not at all confident" to (10) "Totally confident" in that judgement. Where respondents indicated they could not complete the hypothetical task under a particular condition, a value of '0' was assigned on the confidence scale. Computer self-efficacy was then assessed in terms of magnitude, calculated as the number of "YES" responses given, and strength, taken as the sum of the confidence ratings across the performance levels.

Computer use was assessed in terms of frequency of use and actual daily use (Huff et al. 1995). For frequency of use, the respondents recorded on a scale ranging from (1) "Several Times a Day" to (6) "Less Than Once a Month", the response that best approximated how frequently they used a computer. For actual daily use, respondents indicated (for the average working day on which a computer was used) the amount of time spent using the system.

Training. For this item, respondents indicated on a 5-point scale ranging from (1) "No training" to (5) "Very extensive training", the extent to which computer training had been received through each of four sources: college courses, vendor training, in-house training, and self-study (Igbaria and Chakrabarti 1990). The training index was determined as the sum of the scale responses.

Education. For this item, an existing scale (Igbaria and Chakrabarti 1990) was modified to include the range of educational levels relevant to the research context. Respondents then identified, on a scale ranging from (1) "Some High School or Less" to (8) "Completed Graduate or Professional Degree", the highest level of education attained.

Organisational support was measured using an existing 8-item scale incorporating management encouragement and support provided (Igbaria and Chakrabarti 1990). The respondents were asked to indicate on a 5-point scale ranging from (1) "Strongly agree" to (5) "Strongly disagree", the extent of their agreement or disagreement with each statement. An index for organisational support was then computed as the sum of the scale responses.

Task uncertainty. Using an existing 4-item scale (House and Dessler 1974), respondents indicated (on the respective 5-point scales), the extent to which tasks were repetitive, structured, similar or varied. The index for task uncertainty was taken as the sum of the scale responses.

Computing opportunities were assessed in terms of opportunities to develop sophistication and task-technology fit. For opportunities to develop sophistication, respondents indicated for each of three statements, the extent to which the job afforded opportunities to enhance breadth of capability, depth of capability, and finesse. For task-technology fit, respondents indicated for each of four statements, the extent to which computing technology aided task performance. For both measures, the responses were recorded on 5-point scales ranging from (1) "Not at all" to (5) "To a very great extent", and the respective indices computed as the sum of the scale responses.

4. Data Analysis And Results

Structural equation modelling defines an approach that simultaneously assesses the measurement model (for construct validity) and the corresponding structural model. In this study, this approach was implemented using *Partial Least Squares* (PLS), a component-based second generation multivariate technique for data analysis. This technique has been widely accepted among IS researchers as a powerful approach to examining causal models with multiple constructs and multiple measures and as appropriate to the early stages of theory development (Compeau and Higgins 1995b; Igbaria and Iivari 1995; Rivard and Huff 1988).

The Measurement Model (Construct Validity)

The measurement model was assessed in terms of reliability (convergent validity) and discriminant validity. In determining convergent validity, individual item reliability, internal consistency, and average variance extracted were examined (Fornell and Larcker 1981). For *individual item reliability,* items with a minimum factor loading of ±0.50 were considered very important (Hair et al. 1979). Factor loadings greater than 0.70 were particularly meaningful since this implies the item explains at least 50 percent of the variance in the construct and has more explanatory power than error. Excepting frequency of use and computer self-efficacy magnitude, the factor loadings ranged from 0.88 to 0.99. Since frequency of use and computer self-efficacy magnitude exhibited factor loadings greater than 0.50 (at 0.54 and 0.65, respectively) these items were retained. For *internal consistency*, composite reliabilities of 0.70 or greater are sufficient (Nunnally and Bernstein 1994). The composite reliability coefficients ranged from 0.63 to 0.79; since the reliability coefficients for computer use and computer self-efficacy were just below the recommended guideline (at 0.63 and 0.65, respectively) these items and their indicators were retained for consistency and comparability; however, future research is needed to refine these measures and improve convergence. Finally, *average variance extracted* was examined; if the average variance extracted is less than 0.50, then the variance due to measurement error is greater than the variance captured by the construct and the validity of the individual indicators and of the construct is questionable (Fornell and Larcker 1981). Since average variance extracted for each construct exceeded 0.50, this test for convergence was satisfied.

To demonstrate *discriminant validity,* the average variance extracted for a construct should be greater than the variance shared between the construct and other constructs in the model (Fornell and Larcker 1981). The results showed the average variance extracted to be consistently greater than the variance shared between the construct and all other constructs. The test for discriminant validity was satisfied, suggesting distinctiveness between the constructs.

In summary, the measurement model displayed an adequate level of convergence and discriminant validity, to the extent that it was appropriate to proceed with theory testing and the evaluation of the structural model (Fornell and Larcker 1981).

The Structural Model

In structural equation modelling, the structural model or path diagram is defined by a set of unobservable constructs (*latent variables*) and the theoretical relationships (*paths*) linking them. A weight (i.e., the standardised path coefficient), representing the impact (or effect) of one variable upon another, is computed and assigned to each path. In the structural model, the effects among the variables involve two dimensions: i) *direct effects* which are assumed between each exogenous variable and the endogenous variable in the block, and ii) *indirect effects* which are assumed between the exogenous variable and the endogenous variable in blocks wherein the paths are defined by one or more intervening variables. The value of a direct path is equal to the value of that path's coefficient. Where more than one step is involved, the value of the indirect path is the product of the coefficients of each path. The total effect is then calculated as the sum of the values of all paths (direct and indirect) from the exogenous variable to the endogenous variable. In this study, PLS was used to estimate the effect of the exogenous variables on the endogenous variables[1]. The estimated path coefficients were also evaluated for significance (i.e., goodness of fit) using the nonparametric test known as *jackknifing*.

The results (in Table 1) provided support for Hypotheses 2a, 2b, and 2e; training (γ = 0.19, $p \leq 0.001$), education (γ = 0.11, $p \leq 0.05$), and computing opportunities (γ = 0.45, $p \leq 0.001$) were shown to have strong direct effects on computer self-efficacy. The small inverse effect observed for task uncertainty (γ = -0.06, $p \leq 0.001$) supported Hypothesis 2d. Contrary to Hypothesis 2c, organisational support had an inverse effect on computer self-efficacy (γ = -0.19, $p \leq 0.001$).

Variables	Computer Self-efficacy	Computer Use: Direct Effects	Computer Use: Indirect Effects	Computer Use: Total Effects
Training	0.19***	0.15***	0.02	0.17***
Education	0.11*	-0.26***	0.01	-0.24***
Organisational Support	-0.19***	0.00	-0.02	-0.02
Task Uncertainty	-0.06***	0.23***	-0.01	0.22***
Computing Opportunities	0.45***	0.32***	0.06	0.38***
Computer Self-efficacy		0.12***		
Computer Use				
R^2	**0.34**	**0.31**		

*$p \leq .05$ **$p \leq .01$ ***$p \leq .001$

Table 1: Predicting Computer Self-efficacy and Computer Use

Consistent with Hypotheses 3a, 3d, 3e, and 3f, training (γ = 0.15, $p \leq 0.001$),, task uncertainty (γ = 0.23, $p \leq 0.001$), computing opportunities (γ = 0.32, $p \leq 0.001$), and computer self-efficacy (β = 0.12, $p \leq 0.001$) had direct effects on computer use (see Table 1). Contrary to expectations, education had an inverse effect on computer use (γ = -0.26, $p \leq 0.001$) and organisational support did not appear to influence computer use; Hypotheses 3b and 3c were not supported. Excepting computing opportunities, the indirect effects on computer use were small.

1 The PLS approach was implemented using the program, LVPLS 1.6 (Latent Variables Path Analysis using Partial Least Squares). The assistance of Professor Magid Igbaria (Claremont Graduate School) is acknowledged in the running of this program which was unavailable to the researcher.

Variables	Direct Effects	Indirect Effects: Through Computer Self-efficacy	Indirect Effects: Through Computer Use	Indirect Effects: Total Indirect Effects	Total Effects
Training	0.23^{***}	0.07	0.02	0.09	0.32^{***}
Education	0.09^{***}	0.04	-0.04	0.00	0.10^{***}
Organisational Support	-0.05^{**}	-0.07	0.00	-0.07	-0.12^{***}
Task Uncertainty	-0.13^{***}	-0.02	0.03	0.01	-0.12^{***}
Computing Opportunities	0.28^{***}	0.16	0.04	0.21	0.49^{***}
Computer Self-efficacy	0.36^{***}		0.02	0.02	0.37^{***}
Computer Use	0.14^{***}				0.14^{***}
R^2	**0.63**				

$^{*}p \leq .05$ $^{**}p \leq .01$ $^{***}p \leq .001$

Table 2: Predicting User Sophistication

The results (in Table 2) showed that training (γ = 0.23, $p \leq 0.001$), computing opportunities (γ = 0.28, $p \leq 0.001$), computer self-efficacy (β = 0.36, $p \leq 0.001$) and computer use (β = 0.14, $p \leq 0.001$) had strong direct effects on user sophistication; Hypotheses 1a, 1e, 1f, and 1g were supported. The direct effect of education (γ = 0.09, $p \leq 0.001$) on user sophistication was also significant, supporting Hypothesis 1b. Consistent with Hypothesis 1d, task uncertainty had an inverse effect of user sophistication (γ = -0.13, $p \leq 0.001$). Contrary to Hypothesis 1c, the effect of organisational support on user sophistication was small and inverse (γ = -0.05, $p \leq 0.01$). The results also showed indirect effects for computing opportunities, training, and organisational support through computer self-efficacy; the remaining indirect effects were found to be small.

5. Discussion

The results (in Table 2) showed the predictors accounted for 63 percent of the observed variance for user sophistication. In particular, the roles of training, computing opportunities, and computer self-efficacy in furthering user sophistication were emphasised; task uncertainty and computer use were also shown to impact user sophistication. The lack of strong practical support for the role of education suggests user sophistication is not limited by the level of education attained. Contrary to expectation, organisational support had an inverse effect on user sophistication.

Training has strong implications for user sophistication. Since user sophistication reflects the skills a user can bring to bear on work-related tasks, it may be suggested that training, to be effective, should emphasise experience, experimentation, and requisite skills for task performance. Training also impacted user sophistication through its effect on computer self-efficacy, suggesting that users who perceive themselves as able to develop computing skills (through training) become more confident in their ability to use these skills and tend also to improve their sophistication. Organisations which desire improving on IT investment value (through the allocation of training resources for optimal benefit) must therefore train and equip their users with the knowledge and skills required to assist their effective use of computing technology in the working environment.

Computer use, which had strong implications for user sophistication, was strongly influenced by computing opportunities. From a managerial perspective, while these findings imply that higher usage users develop more sophistication, since use depends on the task environment, any effort to enhance sophistication through computer use must consider the task environment also.

Consistent with expectation, computing opportunities had a strong, positive direct impact on user sophistication; this effect was further strengthened through its impact on computer self-efficacy and computer use. From a managerial perspective, computing opportunities appear to determine the extent to which user sophistication benefits task performance, and the extent to which skill development mechanisms can effectively enhance user sophistication.

Task uncertainty was found to negatively impact user sophistication; this effect may be interpreted in a number of ways. For example, where task portfolios confine users to a narrow set of basic functions, neither breadth nor depth of capability may be furthered; conversely, if basic skills are required across a number of computing domains, breadth of capability may develop while depth of capability remains limited. An assessment of skill requirements should assist organisations in determining an appropriate balance of skills for successful task performance. Hence, a lower level of literacy across a range of computing domains may be appropriate in one instance, and a higher level of literacy within a narrower set of computing domains more effective for another situation.

Contrary to expectation, organisational support inversely affected user sophistication. From a theoretical perspective, it seemed reasonable to suggest that increasing levels of organisational support would lead to increasing levels of user sophistication, since the user would have greater access to the resources required to improve proficiency. One plausible explanation for this finding suggests that sophisticated users may be more self-sufficient making fewer demands on support mechanisms. For less sophisticated users, the availability of 'instant help' (where the support person quickly solves the problem without educating the user on why it occurred and how it is redressed) may hinder the development of personal expertise. Skill development may also become neither necessary nor urgent, since users may tend to rely on external assistance and rarely try to develop skills that go beyond basic requirements. From a managerial perspective, it is suggested that user assistance include an explanation of what is being done, suggestions for why the problem occurred, and tips for addressing the problem should it recur. Self-sufficiency may also be encouraged by providing easy-to-read documentation and 'handy hints'. Through modelling and verbal persuasion, support may also assist users to develop confidence in their ability to use computers (Bandura 1977). For more sophisticated users, there may be a need for proactive support that 'goes ahead' of the user, enabling organisations to develop a repository of highly skilled users who can assist others through peer networking and in-house expert training.

The research findings also suggested that as users become more confident in their ability to use computers and to use them successfully, they may become encouraged to further their knowledge of computing technology. It would be reasonable to expect such users to actively seek more knowledge on the different computing tools available, to develop a deeper understanding of certain tools and how to use more aspects of those tools, and to endeavour to apply their knowledge and skills to different aspects of the task environment. A number of specific problems, including IT-related physiological conditions such as computer anxiety, may be traced to low self-efficacy; low self-efficacy may also be symptomatic of training needs and the inadequacy of experiential opportunities. For practitioners, these results emphasise the importance of finding ways to boost user confidence. For example, the computer self-efficacy measure may be used to collect information on user competencies which may be useful for assessing training needs, for selecting trainees, and for determining appropriate training methods. An assessment of computer self-efficacy may also assist organisations to identify those conditions which have debilitating effects on user confidence. For example, users who find it difficult to perform tasks using on-line help functions may be deficient in their understanding of the help function. Organisations can also assist users to improve personal efficacy in a way that accurately reflects their capabilities, through training, modelling, and reassurance of their ability to master the use of computers.

This research also demonstrated the value of the user sophistication measure (Huff et al. 1995). As organisations continue to invest in IT and IT-related support with little evidence of 'pay-back', the user sophistication instrument offers the means whereby skill levels and skill requirements may be assessed. With this knowledge, organisations can develop benchmarks for skill development and appropriately allocate resources for training and support. Effective appropriation may also require an assessment of task requirements and the extent to which additional skills can enhance performance levels.

Strong support was provided for the effects of computing opportunities and training on computer self-efficacy, underscoring the importance of providing users with on-the-job opportunities to use computers and training that is consistent with skill requirements for successful task performance. Education was also found to positively impact computer self-efficacy, suggesting that higher education may boost user confidence towards computing technology. Contrary to expectation, organisational support had an inverse effect on computer self-efficacy. A possible explanation for this result suggests that confidence improves in the presence of requisite skills; hence, confident users are less likely to rely on organisational support while those who rely on organisational support may never develop a belief that they are, or can become, capable of performing the task themselves. Finally, task uncertainty did not have a strong direct effect on computer self-efficacy, suggesting the impact of task uncertainty on computer self-efficacy may be influenced by variables not considered in the research model. Overall, the determinants accounted for 34 percent of the variance observed for computer self-efficacy. Although these results represent an improvement on previous research (Compeau and Higgins 1995b; Igbaria and Iivari 1995), other determinants are suggested (Bandura 1977) which may be considered in future research.

Finally, the impact of task uncertainty, computing opportunities, training, and computer self-efficacy, on computer use was highlighted. Contrary to expectation, organisational support and education had negative effects on computer use. Except for computing opportunities, computer self-efficacy did not play a very important role in partially mediating the determinant effects on computer use. Although the determinants accounted for 31 percent of the variance observed, the low variance observed implies other determinants and belief systems which impact computer use; consideration of these is suggested for future research.

6. Implications, Limitations, And Conclusion

This research makes a number of contributions to the current knowledge regarding end-user computing and IT-related behaviours. These include support for the research model and a better understanding of the factors that further user sophistication in the workplace. This research also confirmed previous studies regarding the usefulness of social cognitive theory for explaining IT-related behaviours, and provided further evidence of the role of computer self-efficacy as a partial mediator of determinant effects on IT-related behaviours (Compeau and Higgins 1995b). From a measurement perspective, evidence was provided for the validity and reliability of the computer self-efficacy and user sophistication measures (Compeau and Higgins 1995b; Huff et al. 1995). The computing opportunities instrument also appeared useful as a measure of task factors which impact user sophistication, computer self-efficacy, and computer use. However, further research is required to establish construct validity through a continuing assessment of the measure of computing opportunities over a variety of studies in similar and different contexts.

Although support was provided for the conceptual model, this investigation was defined by a number of limitations which should be considered in respect of interpretation and future research. Since the study was limited to the administrative (mostly, non-clinical) user population of a health organisation, contextual constraints (including non-response bias and selection bias) may limit interpretation and the extent to which the findings may be generalised. The use of cross-sectional research also limits interpretation; while social cognitive theory may suggest causality and the PLS analysis provide evidence to support this suggestion, causality can only be inferred, not proven. The research design also did not include a measure of continuous feedback, which is an essential component of social cognitive theory. The construct measures were not without weaknesses; for example, the use of self-report scales may introduce bias which may not reflect the real world, and the methods used for score aggregation, although considered appropriate for this research, do not necessarily represent the best and only methods for aggregating measurement indices. The low factor loadings observed for frequency of use and computer self-efficacy magnitude also suggest further research is needed to refine these measures. Notwithstanding the value of this research, in the light of these limitations, caution is advised in the interpretation of the research findings. Nevertheless, there are a number of opportunities for redressing the research limitations, for extending the research, and for pursuing new avenues of research. These include consideration of experimental or longitudinal research options; extension of the research model by including feedback mechanisms and other determinants and belief systems (e.g., attitudes). Future research may also consider more objective measures for reducing the potential for self-report bias as well as refining the measures for computer use and computer self-efficacy.

The purpose of this study was to investigate the factors influencing the development of user sophistication. In general, this investigation provided sufficient evidence supporting the research model and corroborating the importance of training, task uncertainty, computing opportunities, computer use, and computer self-efficacy for the furtherance of user sophistication in the workplace. Computer self-efficacy was also shown to play an important role in partially mediating the determinant effects on user sophistication. This research contributed to a better understanding of the factors that influence user sophistication and demonstrated the value of social cognitive theory for the explanation of IT-related behaviours. A number of important implications for practitioners arose from the investigation. Overall, this research represents significant progress in the study of user sophistication and self-efficacy, and concludes with suggestions for further analysis, extension of the research model, and directions for new research.

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